GEUS

Geothermal applications for the public

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Geologist Ph.d.

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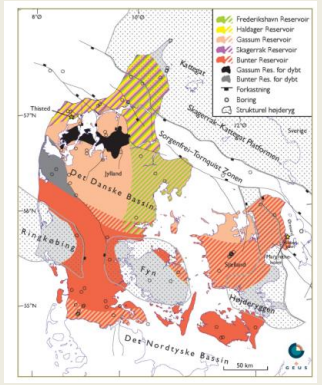
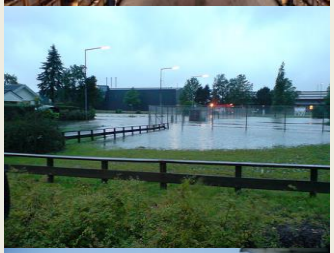
Danish Ministry of Energy, Utilities and Climate



Resources for life


Databanks
- National databases on water, oil and gas, minerals and environment
- National core store

Water resources
- National groundwater monitoring for clean drinking water
- National groundwater mapping and hydrological modelling

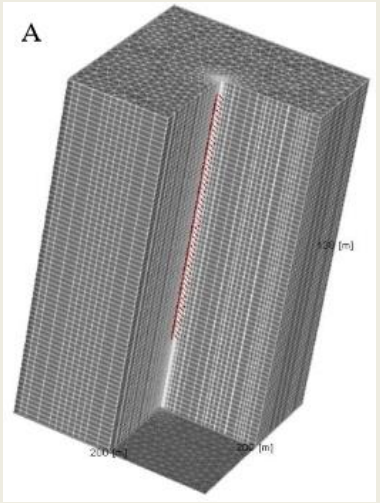
Energy resources
- Hydrocarbon potential in Danish and Greenland sectors
- Geothermal energy, ground source heating and geological storage of CO_2

Mineral resources
- Geological and mineral resource evaluation in Greenland
- Geological mapping and exploration for raw materials in Denmark

Nature and Climate
- Paleoclimate and monitoring of earthquakes and Greenland ice sheet
- Coastal zone management and soil pollution

International Development Activities
- Building expertise in Africa, Asia and South America

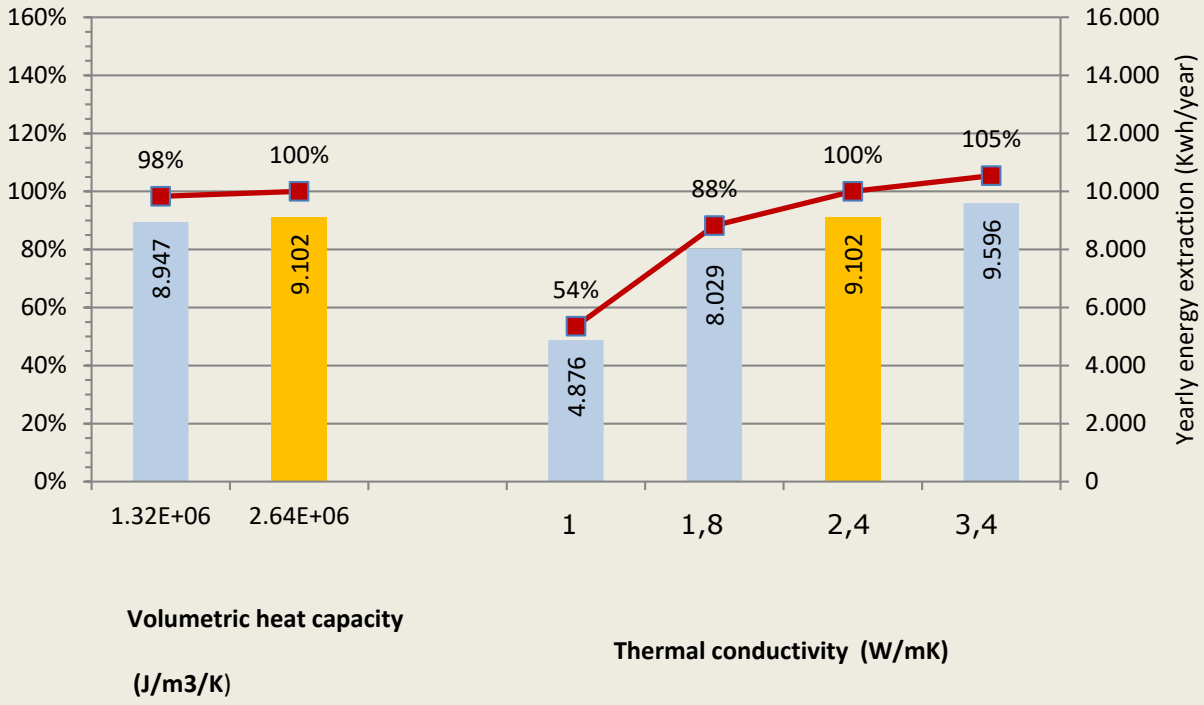
Energy systems based on closed loop boreholes - tools and best practice



Modeling of sensitivity for a 100 m deep BHE

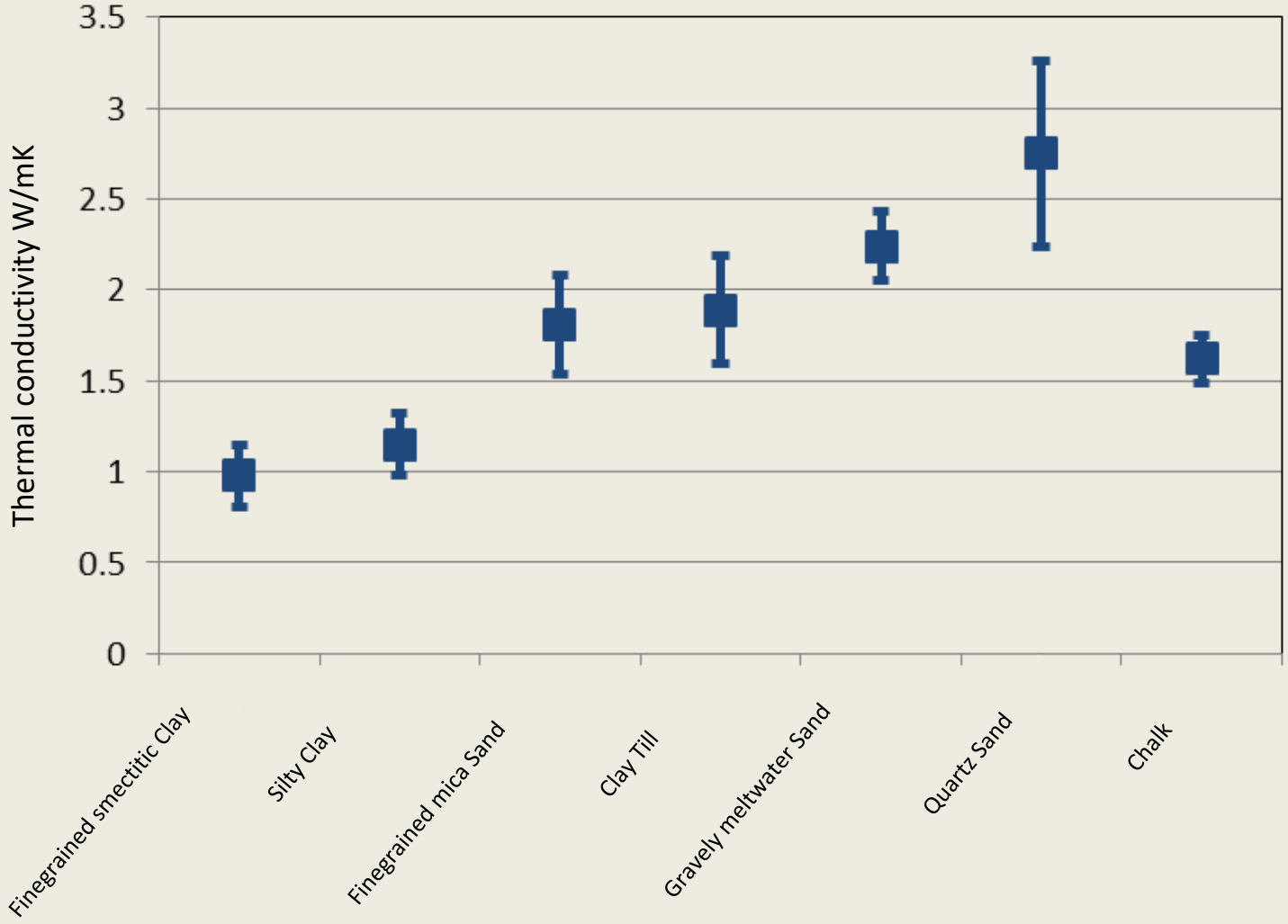
Energy systems based on closed loop boreholes - tools and best practice

Modeling of sensitivity for a 100 m deep BHE



Højberg og Jensen, 2014 (GeoEnergi D20)

Thermal conductivity of common Danish sediment types

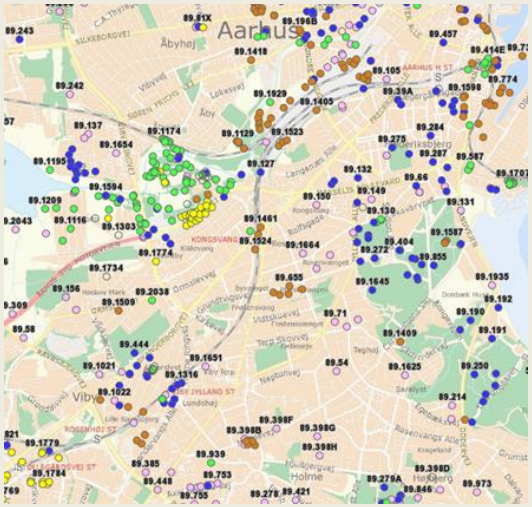


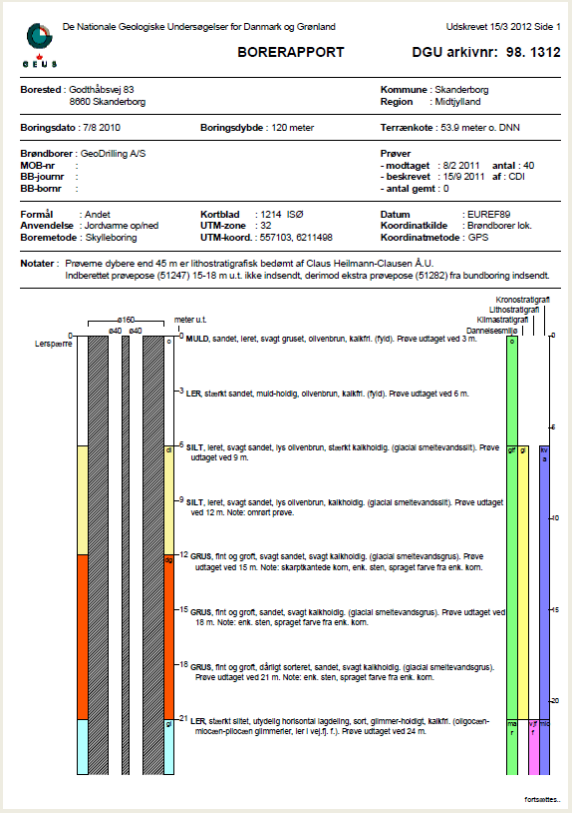
The national borehole database JUPITER

Borehole archive / database founded in 1926

>270.000 borehole descriptions

=> 6 boreholes / km^2





De Nationale Geologiske Undersøgelser for Danmark og Grønland — Udskrevet 15/3 2012 Side 1

BORERAPPORT — **DGU arkivnr: 98. 1312**

Borested : Godthåbsvej 83, 8660 Skanderborg
Kommune : Skanderborg
Region : Midtjylland

Boringsdato : 7/8 2010 — **Boringsdybde** : 120 meter — **Terrænkote** : 53.9 meter o. DNN

Brøndborer : GeoDrilling A/S
MOB-nr :
BB-journr :
BB-bornr :

Prøver
- modtaget : 8/2 2011 **antal** : 40
- beskrevet : 15/9 2011 **af** : CDI
- antal gemt : 0

Formål : Andet
Anvendelse : Jordvarme op/ned
Boremetode : Skylleboring

Kortblad : 1214 IS/Ø
UTM-zone : 32
UTM-koord. : 557103, 6211498

Datum : EUREF89
Koordinatkilde : Brøndborer lok.
Koordinatmetode : GPS

Notater : Prøverne dybere end 45 m er lithostratigrafisk bedømt af Claus Heilmann-Clausen Å.U. Indberettet prøvepose (51247) 15-18 m u.t. ikke indsendt, derimod ekstra prøvepose (51282) fra bundboring indsendt.

Kronostratigrafi
Lithostratigrafi
Klimastratigrafi
Dannelsesmiljø

Lerspærre — ø160 ø40 ø40 — meter u.t.

0 **MULD**, sandet, leret, svagt gruset, olivenbrun, kalkfri. (fyld). Prøve udtaget ved 3 m.

3 **LER**, stærkt sandet, muld-holdig, olivenbrun, kalkfri. (fyld). Prøve udtaget ved 6 m.

6 **SILT**, leret, svagt sandet, lys olivenbrun, stærkt kalkholdig. (glacial smeltevandssilt). Prøve udtaget ved 9 m.

9 **SILT**, leret, svagt sandet, lys olivenbrun, kalkholdig. (glacial smeltevandssilt). Prøve udtaget ved 12 m. Note: omrørt prøve.

12 **GRUS**, fint og groft, svagt sandet, svagt kalkholdig. (glacial smeltevandsgrus). Prøve udtaget ved 15 m. Note: skarpkantede kom, enk. sten, spraget farve fra enk. kom.

15 **GRUS**, fint og groft, sandet, svagt kalkholdig. (glacial smeltevandsgrus). Prøve udtaget ved 18 m. Note: enk. sten, spraget farve fra enk. kom.

18 **GRUS**, fint og groft, dårligt sorteret, sandet, svagt kalkholdig. (glacial smeltevandsgrus). Prøve udtaget ved 21 m. Note: enk. sten, spraget farve fra enk. kom.

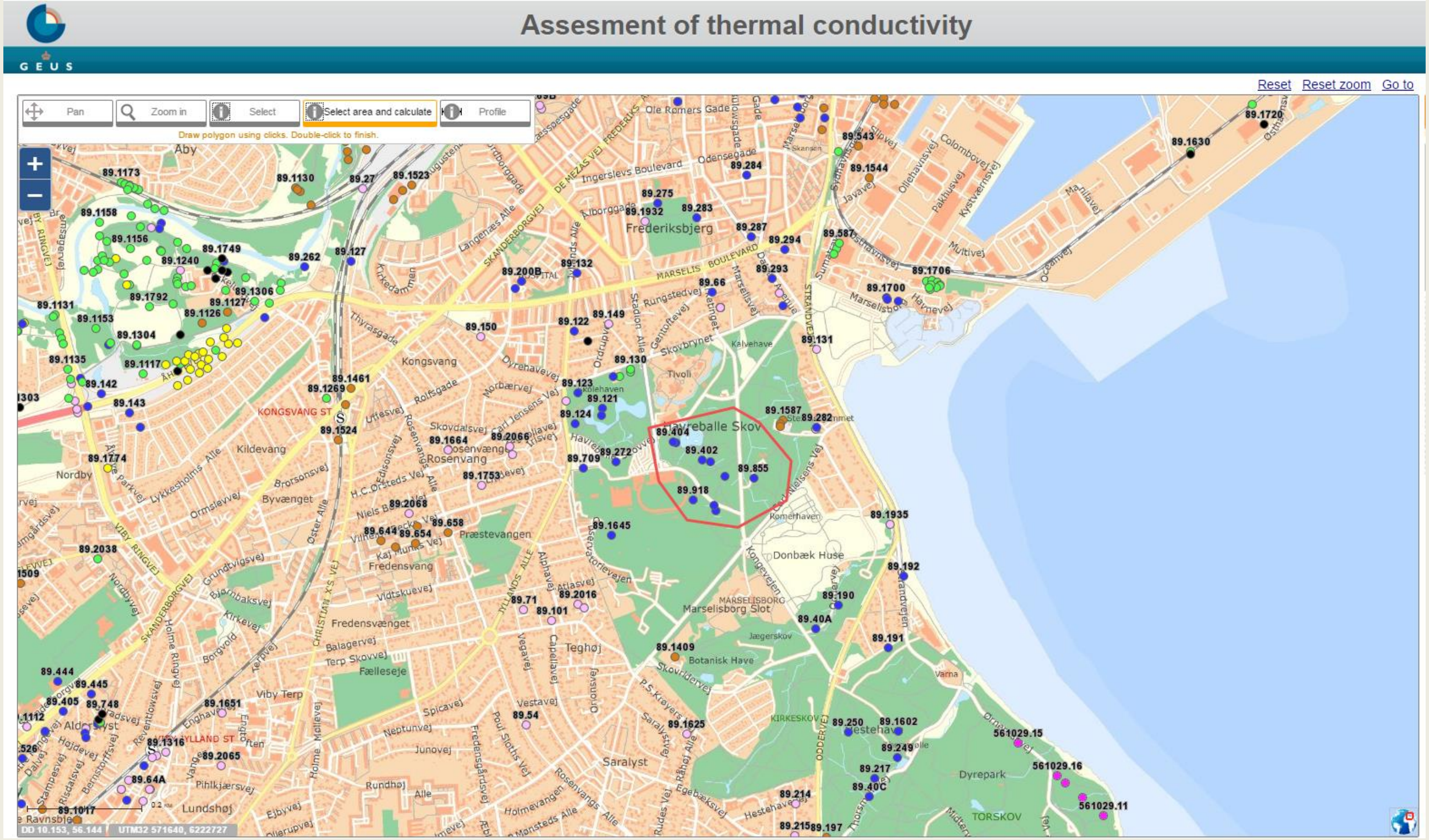
21 **LER**, stærkt siltet, utydelig horisontal lagdeling, sort, glimmer-holdigt, kalkfri. (oligocæn-miocæn-pliocæn glimmerler, ler i vej.fj. f.). Prøve udtaget ved 24 m.

fortsættes..

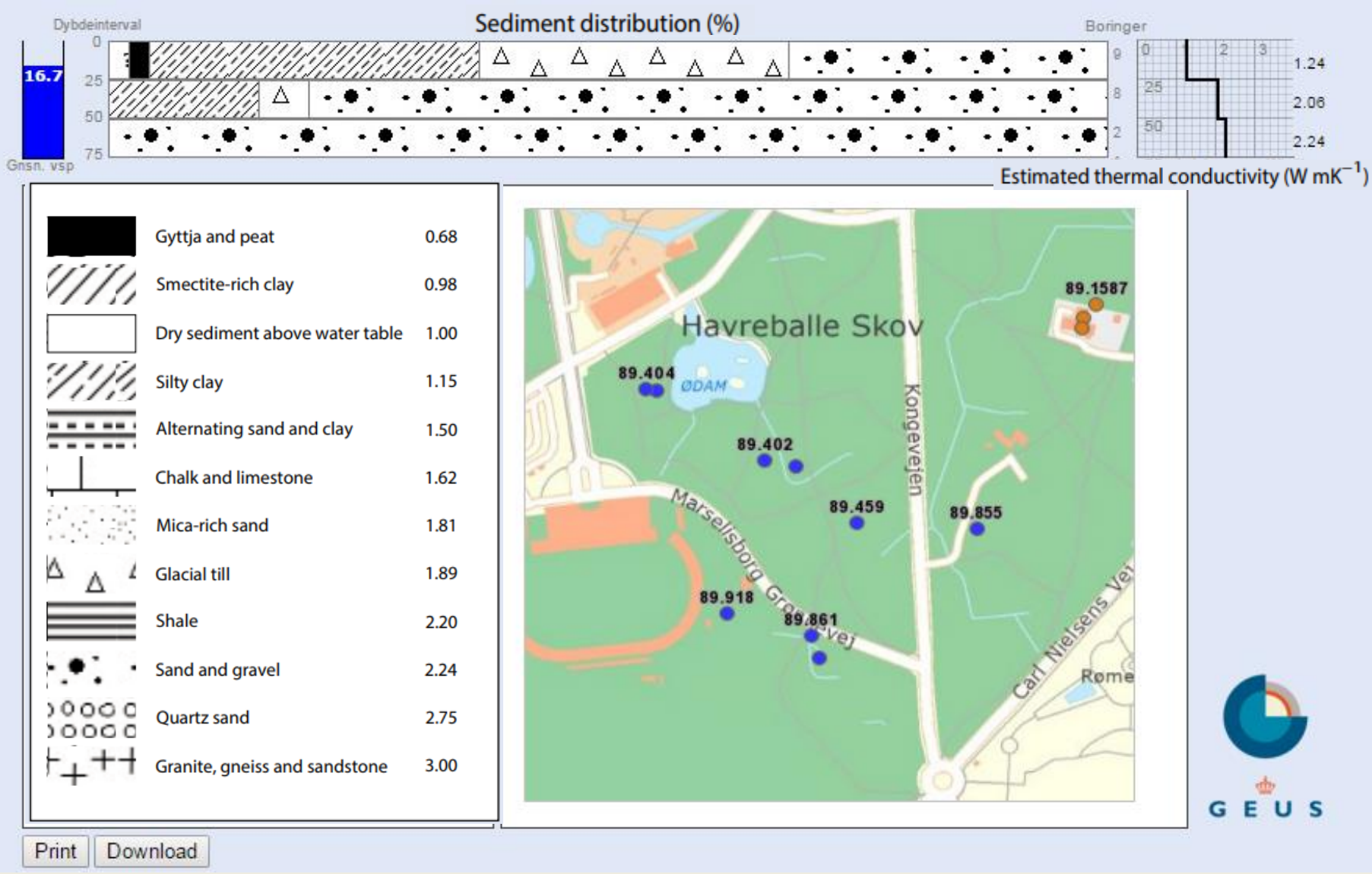
Information is freely available on the web

GEUS

Web based tool to estimate thermal conductivity in new project areas



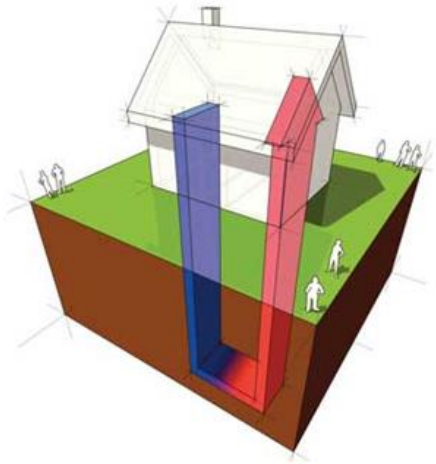
Sediment distribution and estimated conductivity



Integration with external energy calculation programs

Lodrette boringer - Beregner

BETA VERSION



1. Indlæs data fra GEUS

2. Kør beregning

1. Downloade data fra GEUS
2. Tryk på knap "1.Indlæs data fra GEUS"
3. Sæt værdier i grønne bokse
4. Tryk på "2. Kør beregning"

Borehul

	Input	
Antal borehuller:	10	[-]
Længe borehul:	100	[m]
Diameget borehul	0,2	[m]
Borehulsmodstand:	0,16	[(m*K)/W]

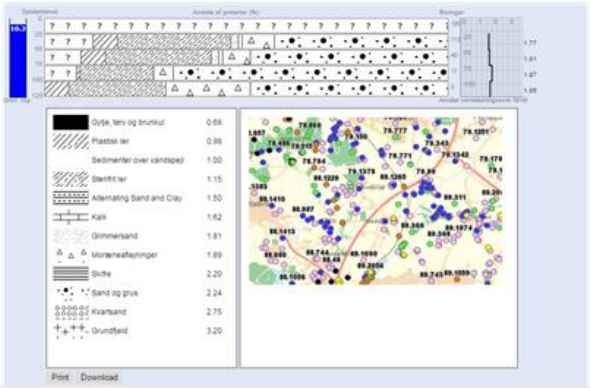
Varmepumpe

	Input	
Installeret effekt:	5000	[W]
Årligt varmebehov:	4000	[kWh]
Varmekreds:	Gulv	
COP:	3,6	[-]

Resultater

	Output	
Start brine temperatur:	9,1	[°C]
Forventet brine temperatur efter 30år:	8,8	[°C]
Slange belastning:	3,61	[W/m]
Varmeledning på jorden (vægtet gennemsnit):	1,9	[W/(m*K)]
Varmekapacitet på jorden (vægtet gennemsnit):	1405	[J/(kg*K)]

Data fra GEUS



Tilføj flere lag manuelt | Slet nederste lag

Nr	Lagtykkelse	Varmeledning	Varmekapacitet
1	25 [m]	1,77 [W/(m*K)]	1402 [J/(kg*K)]
2	25 [m]	1,81 [W/(m*K)]	1409 [J/(kg*K)]
3	25 [m]	1,97 [W/(m*K)]	1413 [J/(kg*K)]
4	25 [m]	1,85 [W/(m*K)]	1397 [J/(kg*K)]

Estimating thermal conductivity in new project areas

The thermal conductivity of the sediments surrounding a BHE is a crucial parameter controlling how much heat that can be extracted

Through sampling and laboratory measurements it has been possible to establish a relationship between lithology and thermal conductivity for a number of common Danish sediment types

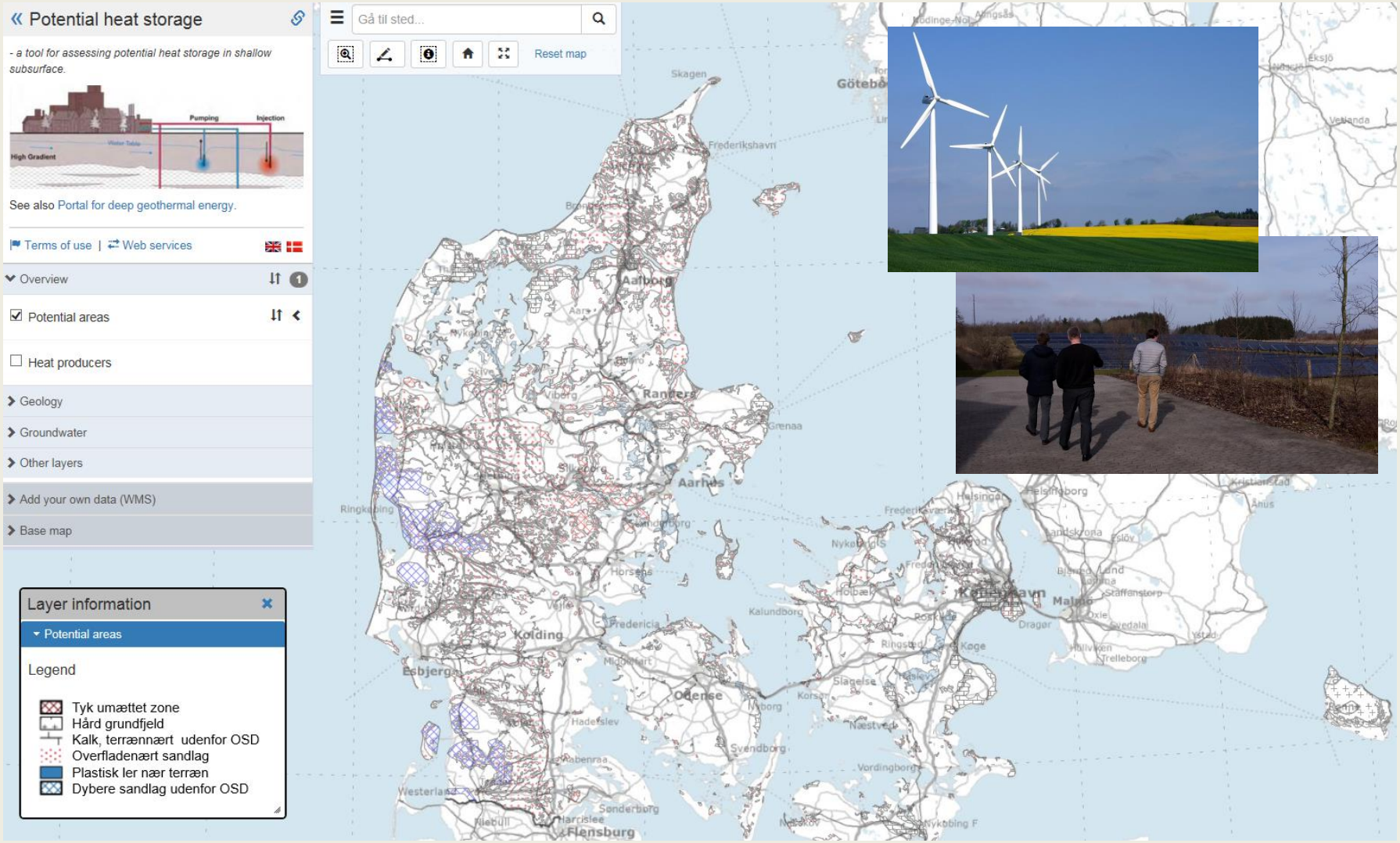
The expected thermal conductivity of common danish sediments is use to estimate the thermal conductivity in areas with no measurements using sediment descriptions available in the national database JUPITER

The application can make aggregated calculations that involve selected drillings within a user-defined polygon at depth intervals of 25 m.

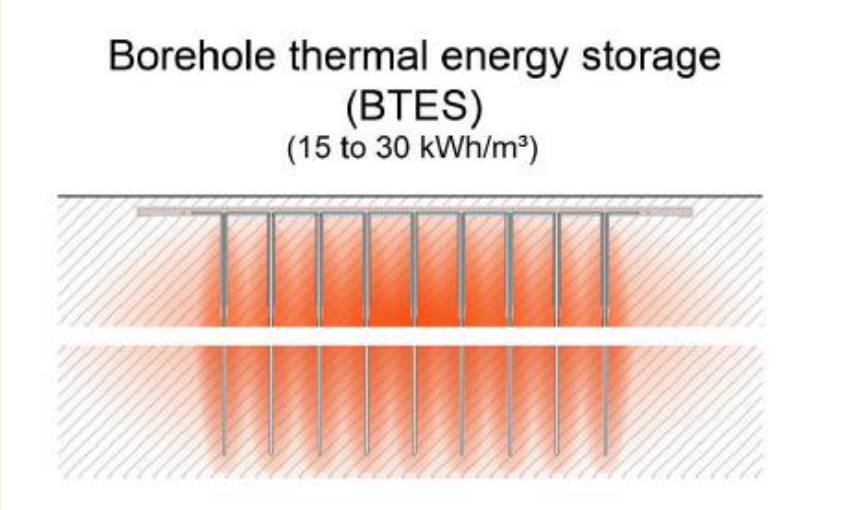
http://data.geus.dk/geusmap/?mapname=termiskejordarter&lang=en

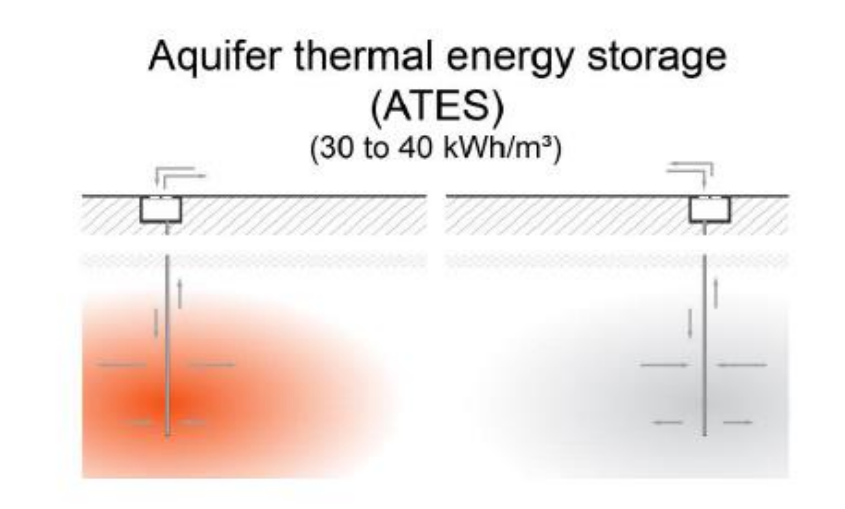
The application has been developed for Danish users and full translation to English has not been implemented yet

Web application for screening local conditions suited for geological heat storage



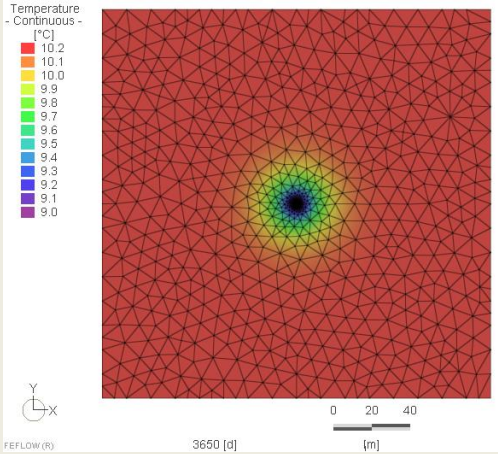
Main storage types



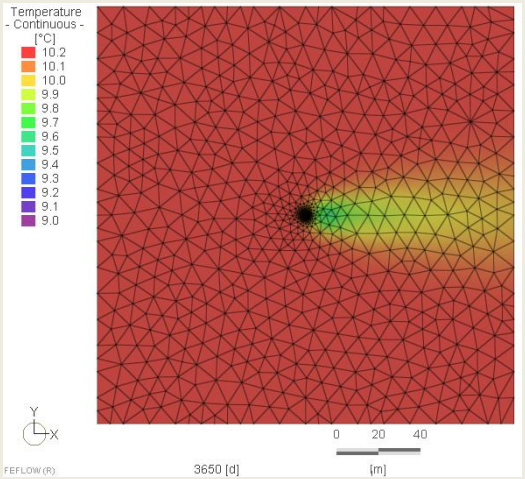


From: www.solites.de

Limited groundwater flow

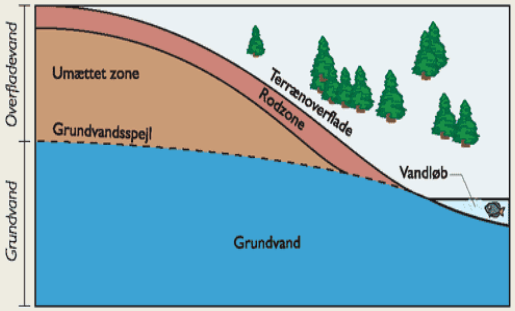


Well known groundwater flow

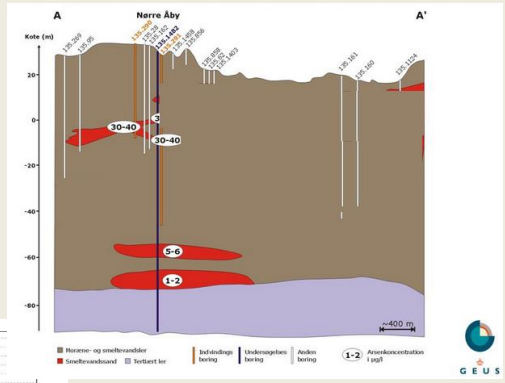


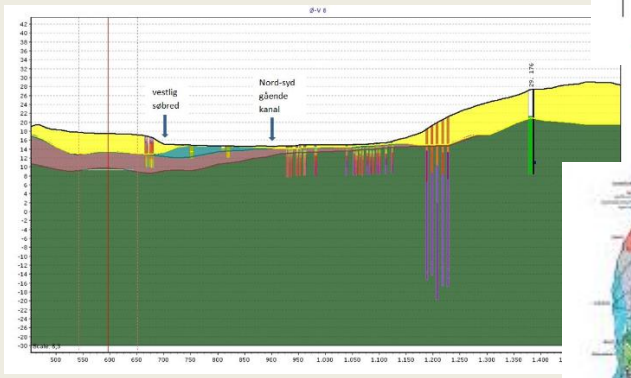
Sites suited for BTES:

1. Areas with a thick unsaturated zone



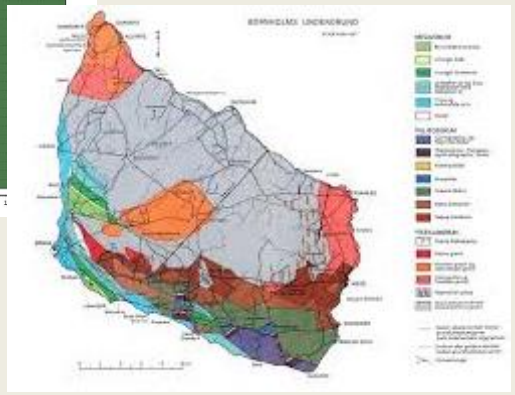
2. Areas with homogenious clay deposits





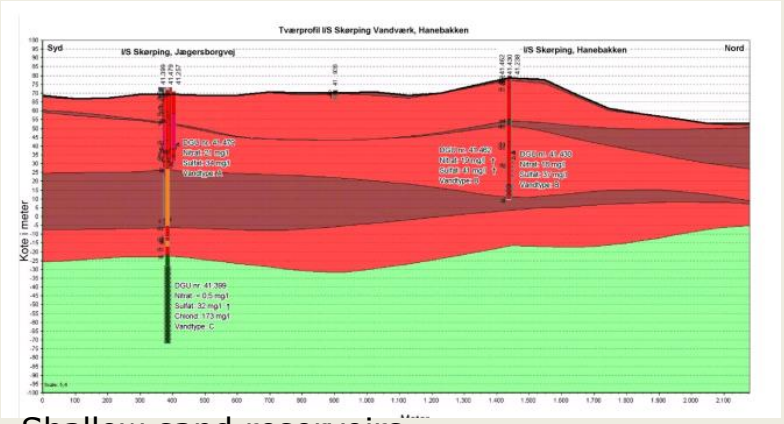
3. Formations of impermeable limestones

4. Impermeable bedrock

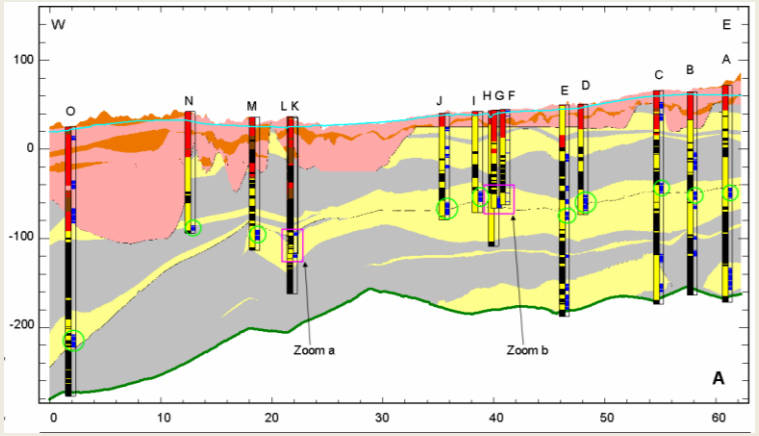


Sites potentially suited for ATES

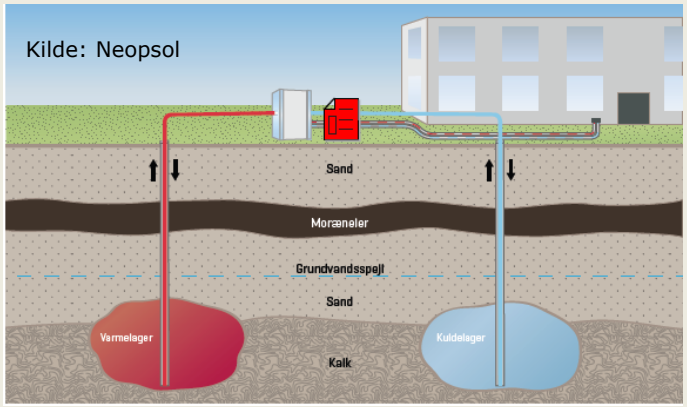
Areas with coherent groundwater bodies



Shallow sand reservoirs

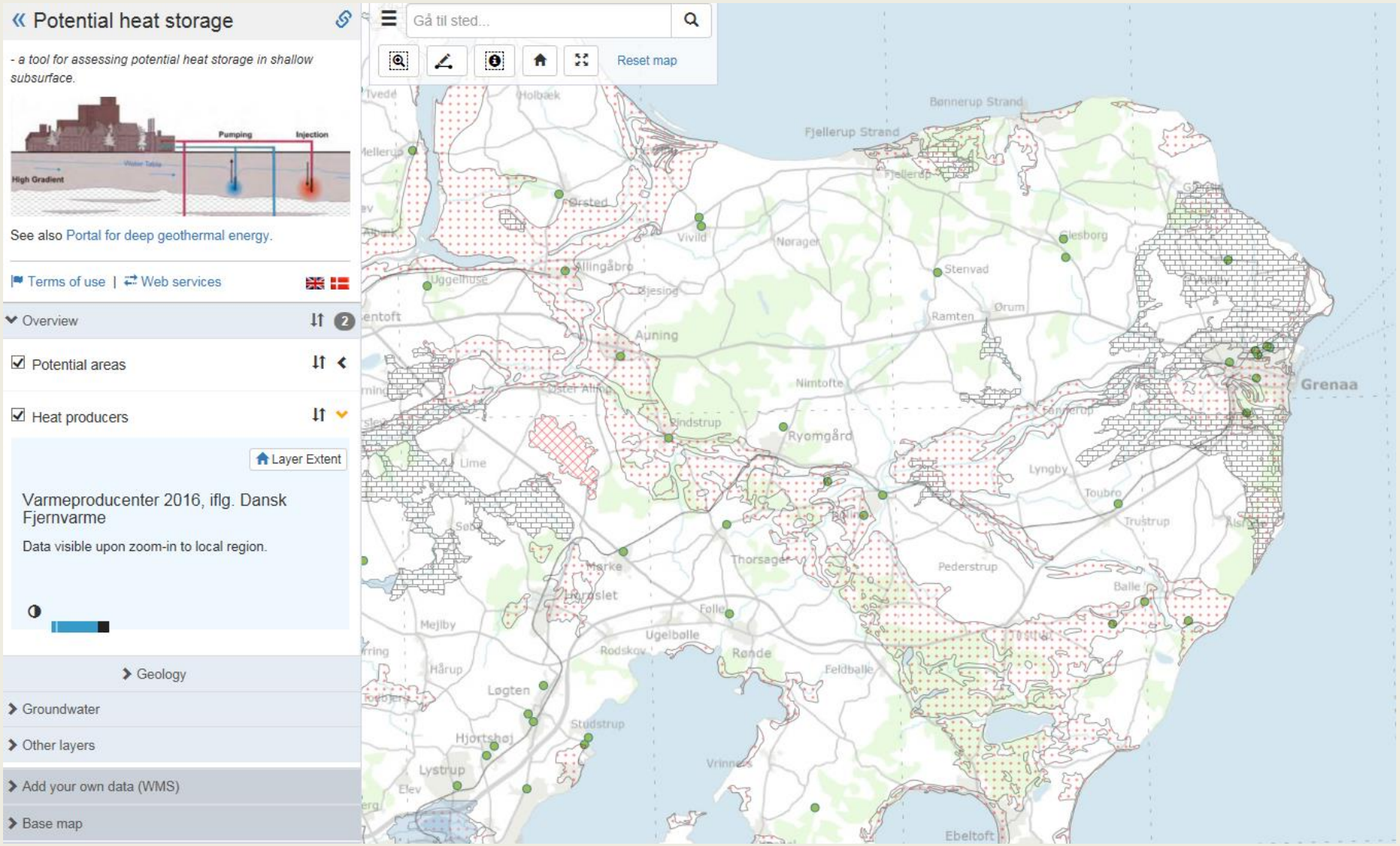


Deepere sand reservoirs

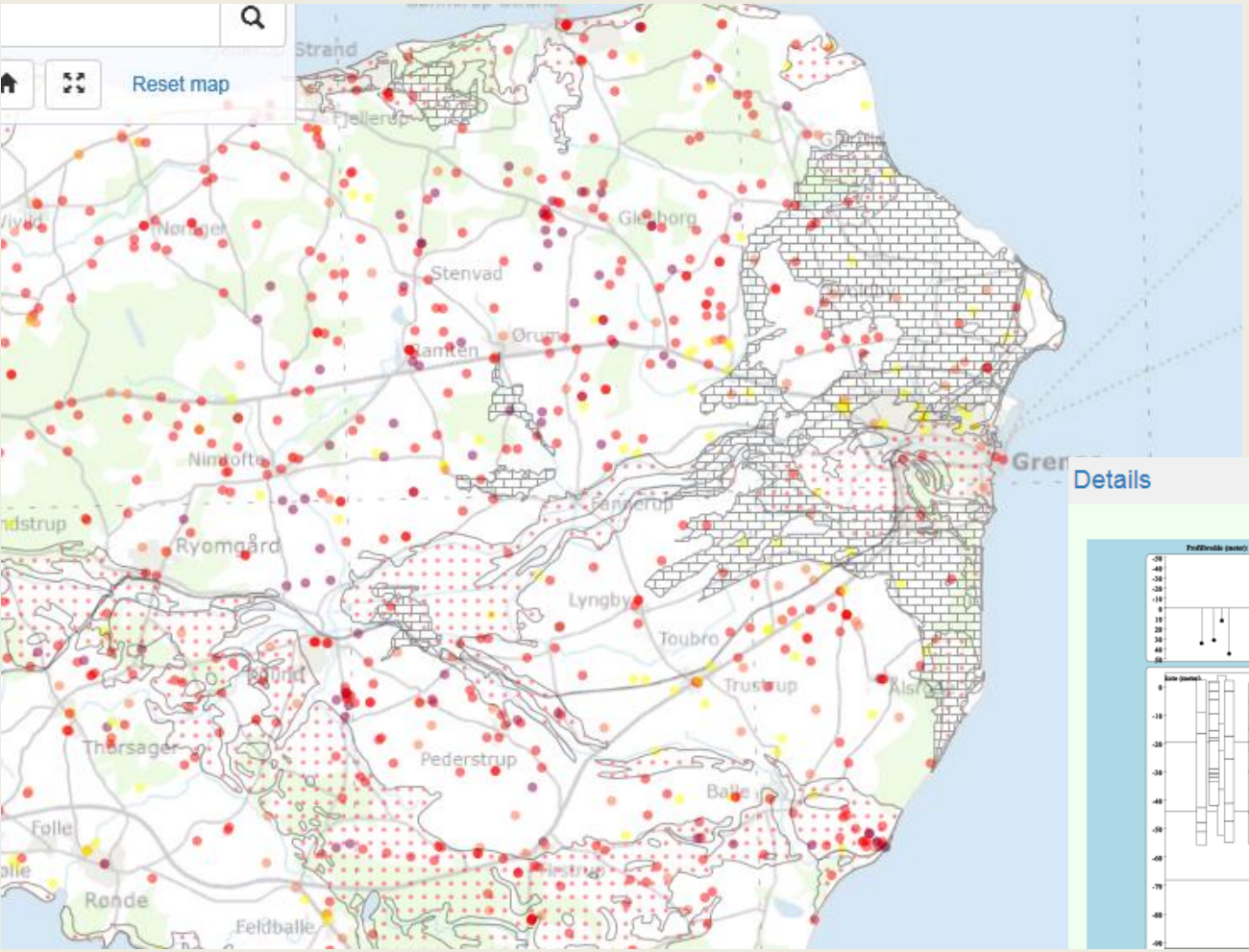


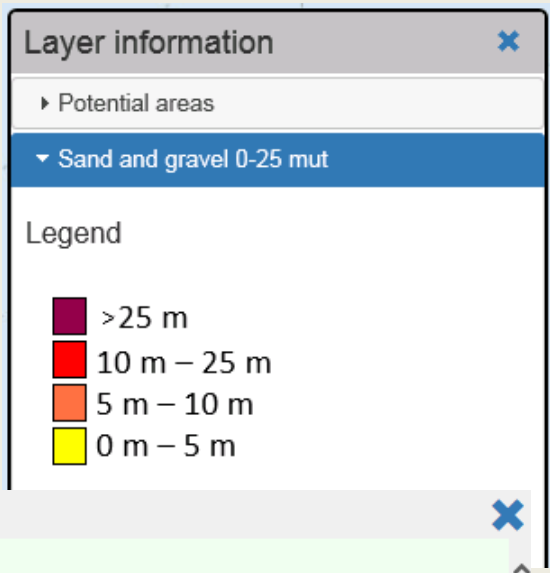
Fractured limestones

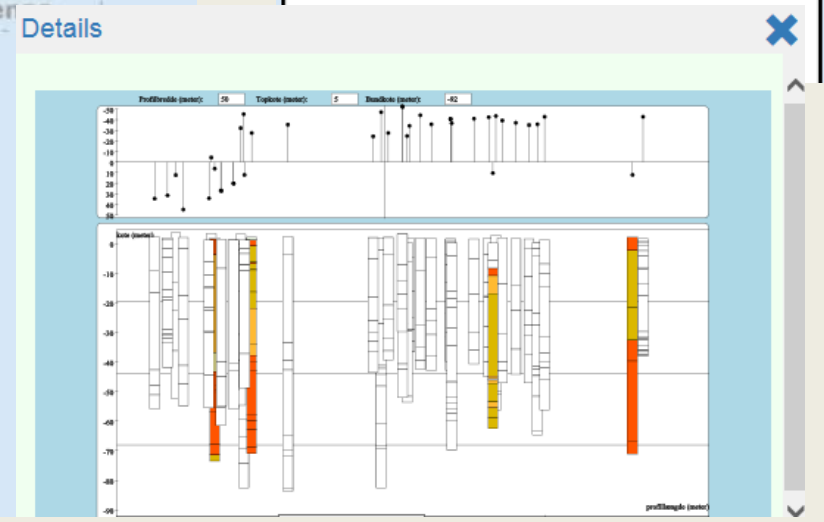
Location of heat plants



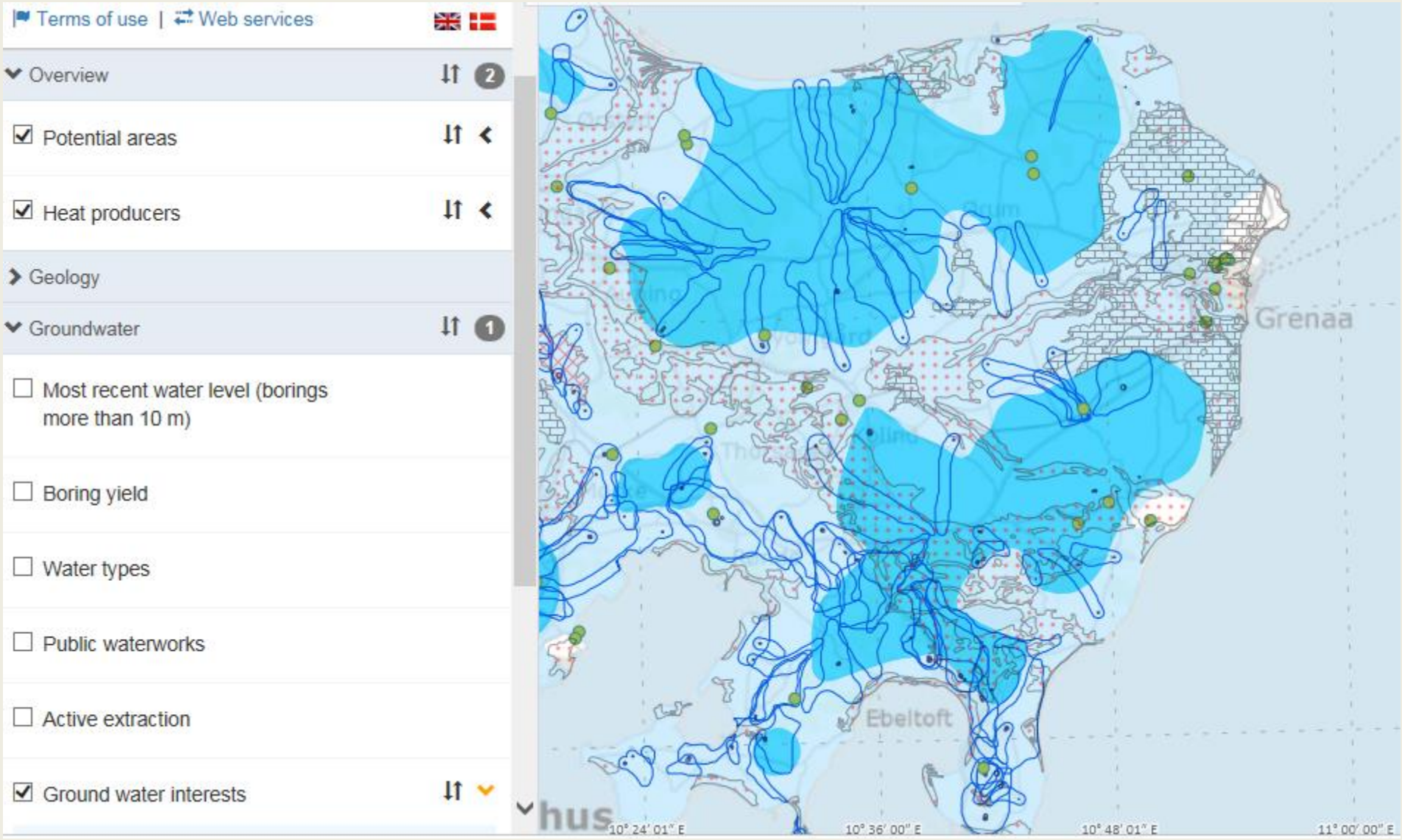
Online information from the national borehole database







Catchment and groundwater protection areas

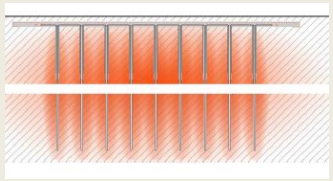


Screening of sites suited for shallow geological heat storage

As part of a national project to map the potential for geological heat storage in Denmark an interactive web tool has been developed.

The tool utilizes relevant data from the Danish Geological Survey (GEUS) and other public databases.

It focuses on finding areas with particular geological settings suited for either BTES or ATES plants and limited conflicting interests.



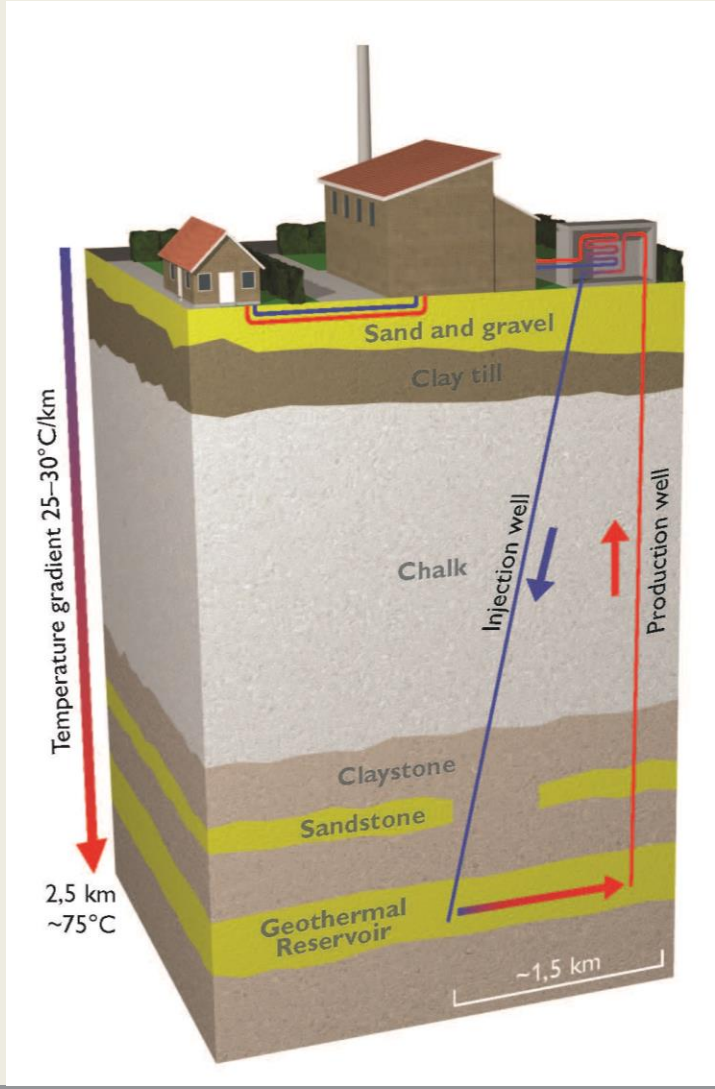
http://data.geus.dk/geusmap/?mapname=varmelagring

The application has been developed for Danish users and full translation to English has not been implemented yet

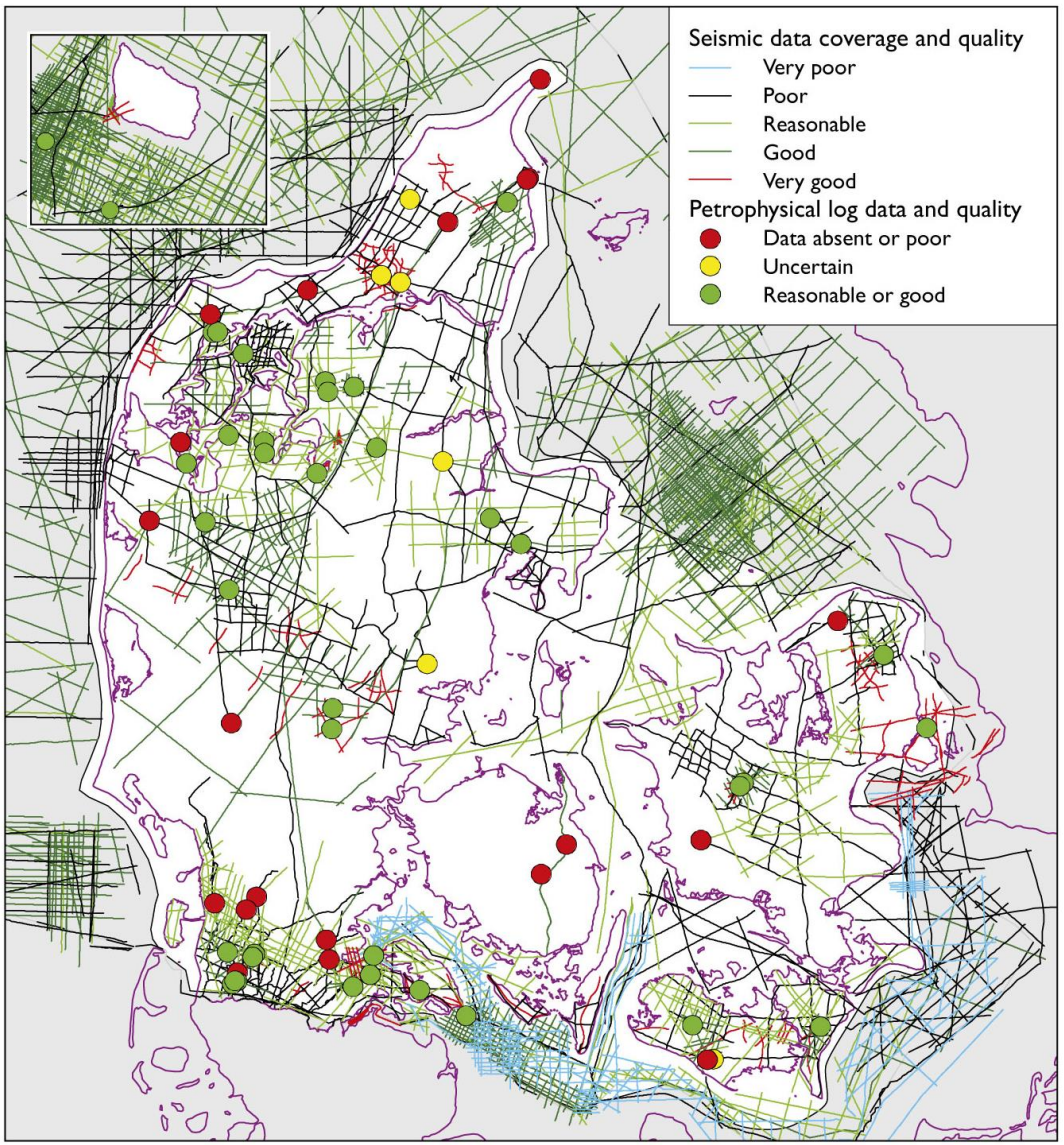
A WebGIS portal for Deep geothermal energy

The purpose of the portal is to:

- Present processed, and interpreted geophysical, geological and petrophysical data relevant to deep geothermal energy (800-3000 m b.s).
- Make these data easily accessible in a manageable way.
- Give stakeholders in the geothermal industry an overview of the composition of the subsurface and the density and quality of the geological data.
- Present an assessment of the geothermal potential at national level in order to direct the geothermal activities towards the most promising areas



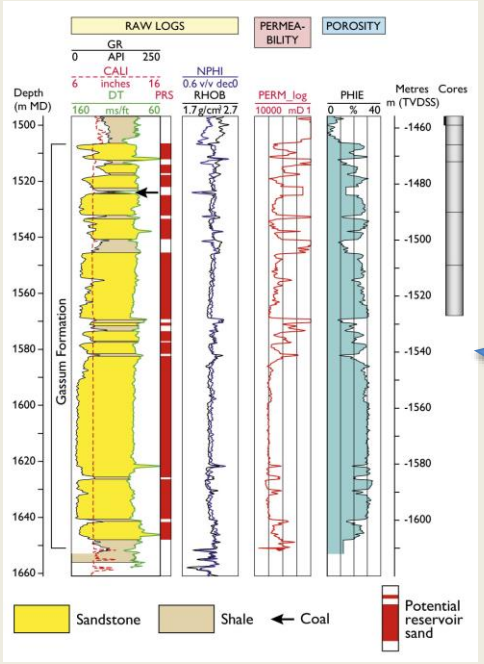
Extent and quality of the geological data



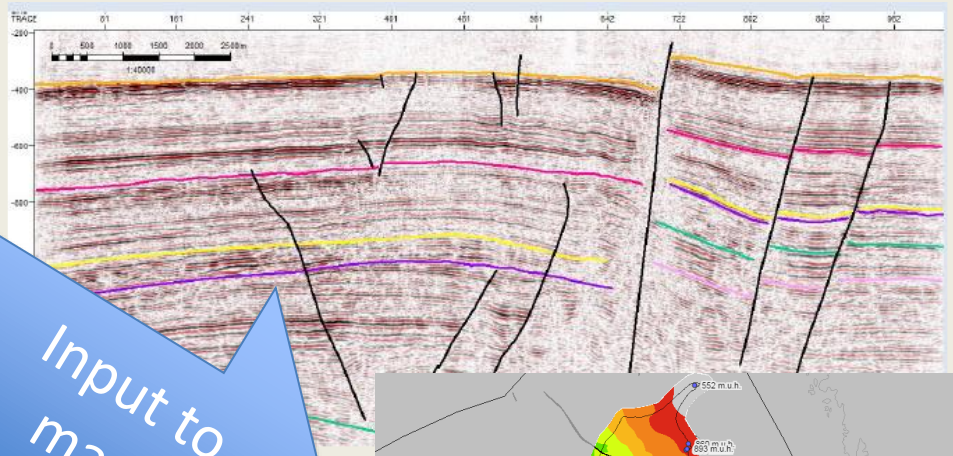
Quality indexes reflect to which degree the data can be used to extract information about geothermal reservoirs in the deep subsurface

Compiled thematic maps

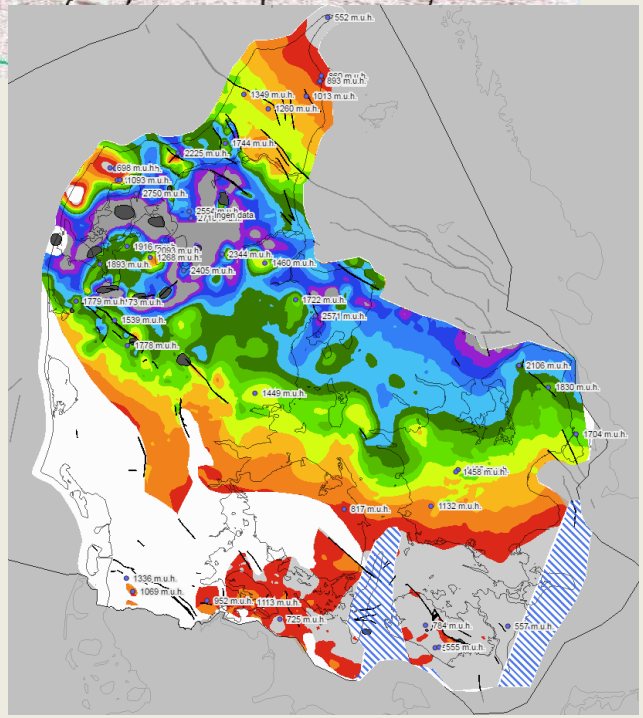
1D data: Well data and cores



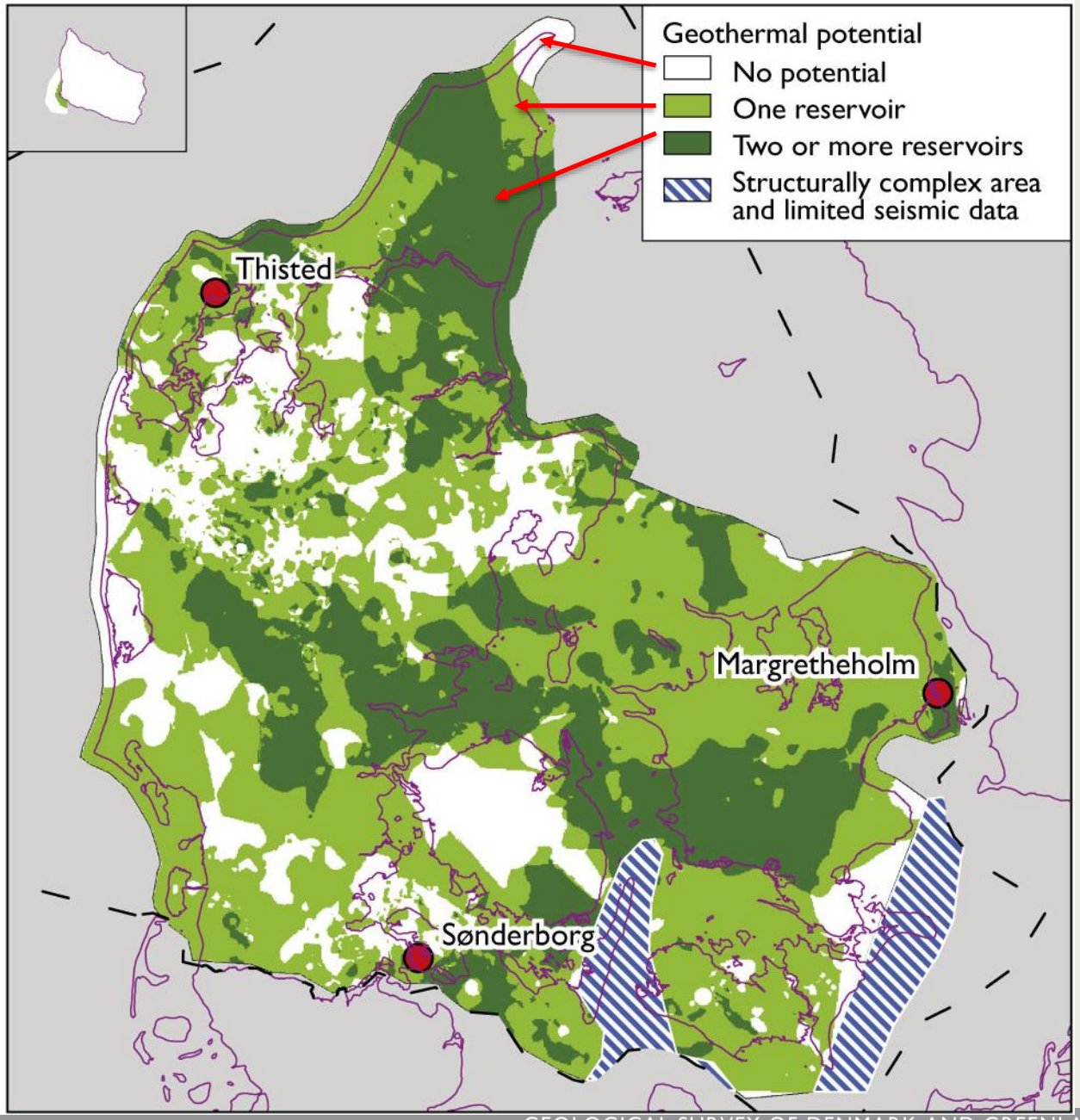
2D data: seimic data



Input to maps



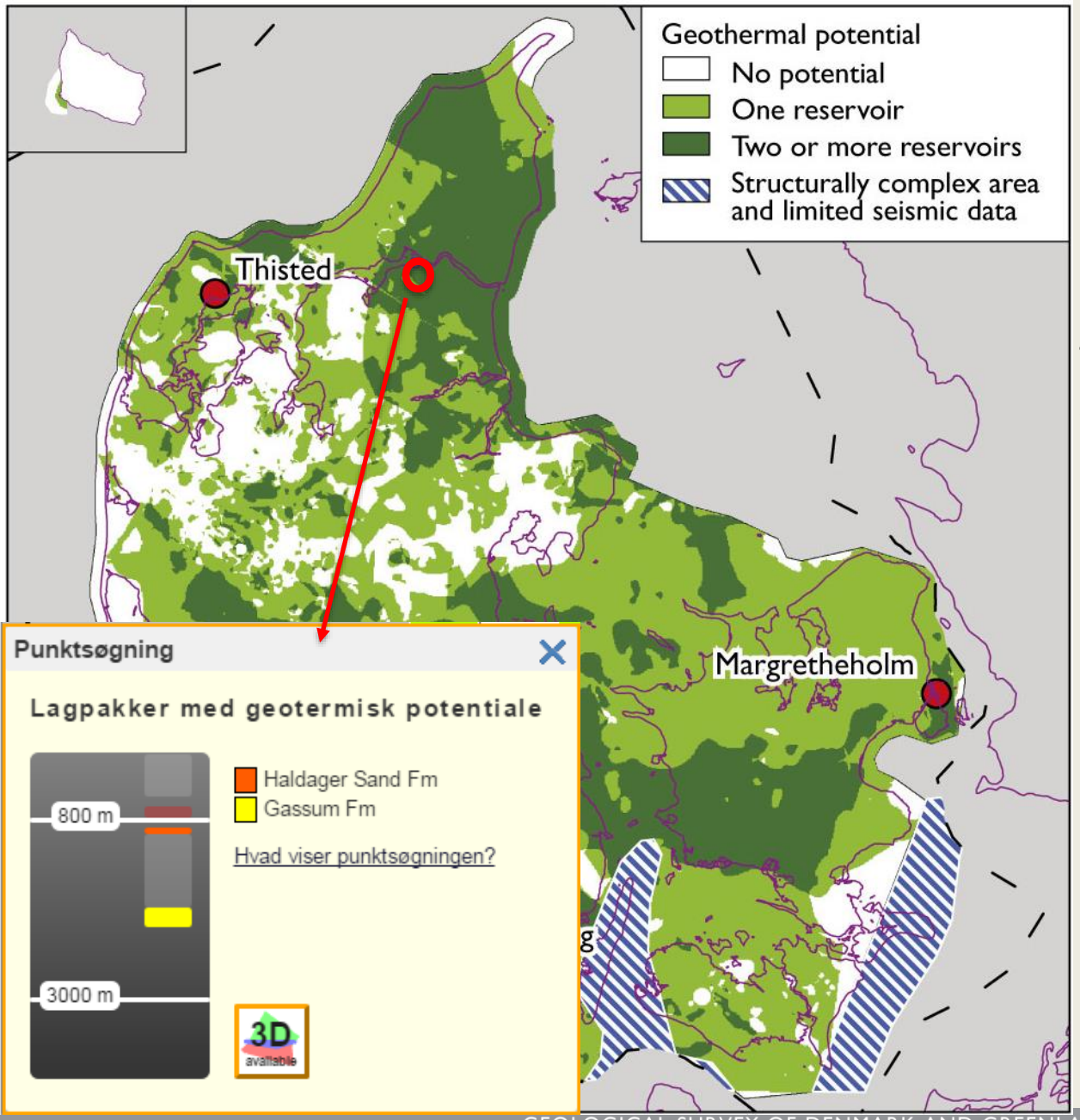
- Depth to reservoir
- Reservoir thickness
- Gross sand
- Potentiel reservoir sand
- Porosity
- Permeability
- Temperature



General reservoir map

(800-3000 m)

● Geothermal plants i DK



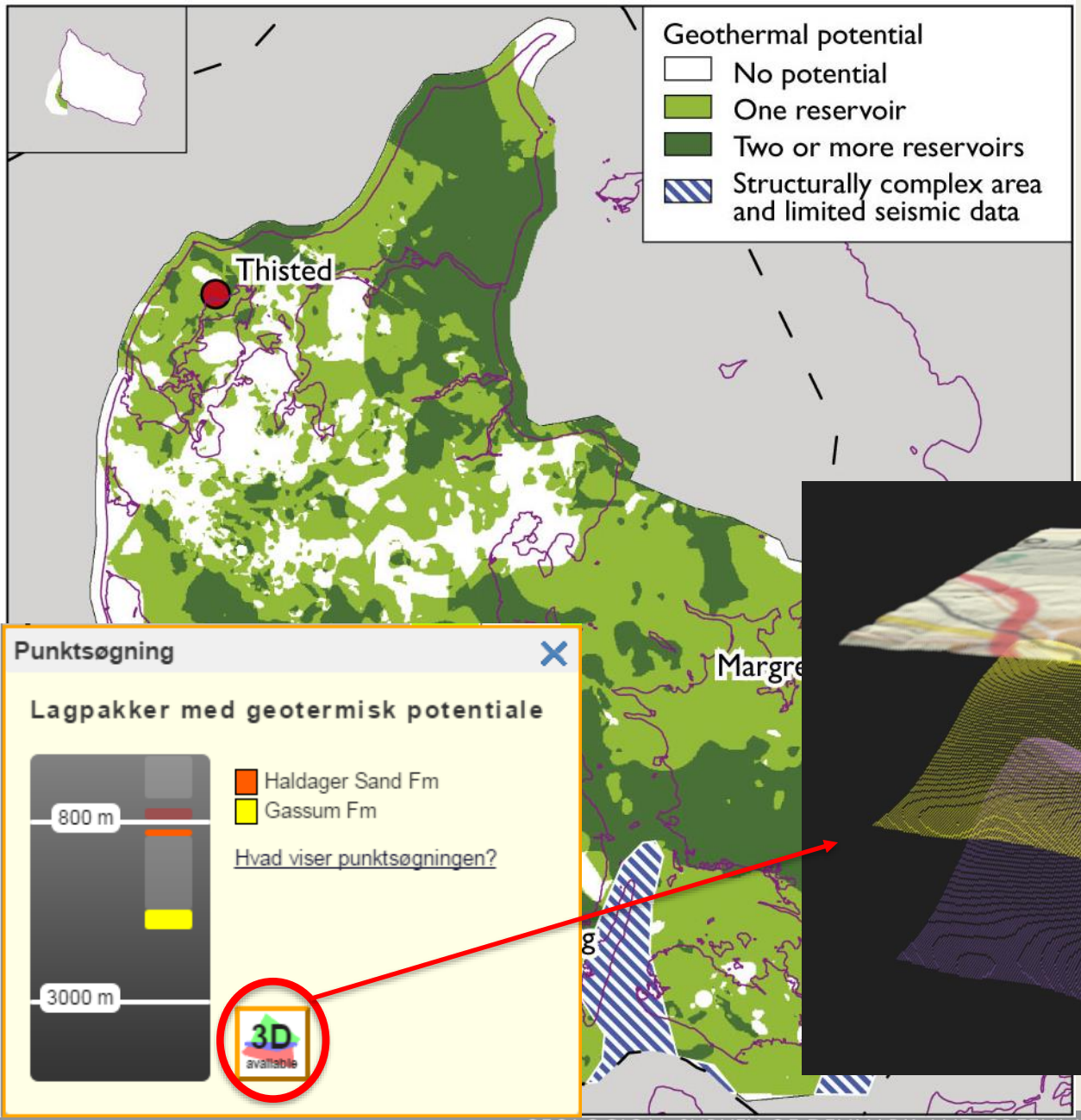
Interactive maps

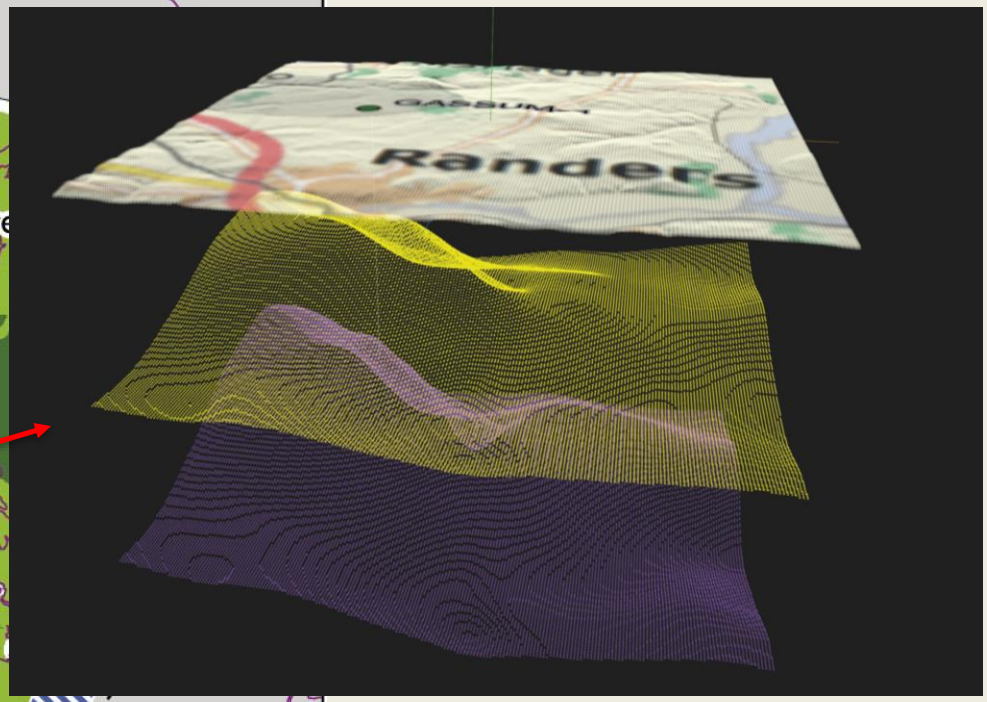
Lithostratigraphy and depth of the mapped resevoirs is shown interactively.

In this example the Gassum and the Haldager Sand Formations have a geothermal potential within the depth interval (800-3000m)

Interactive maps

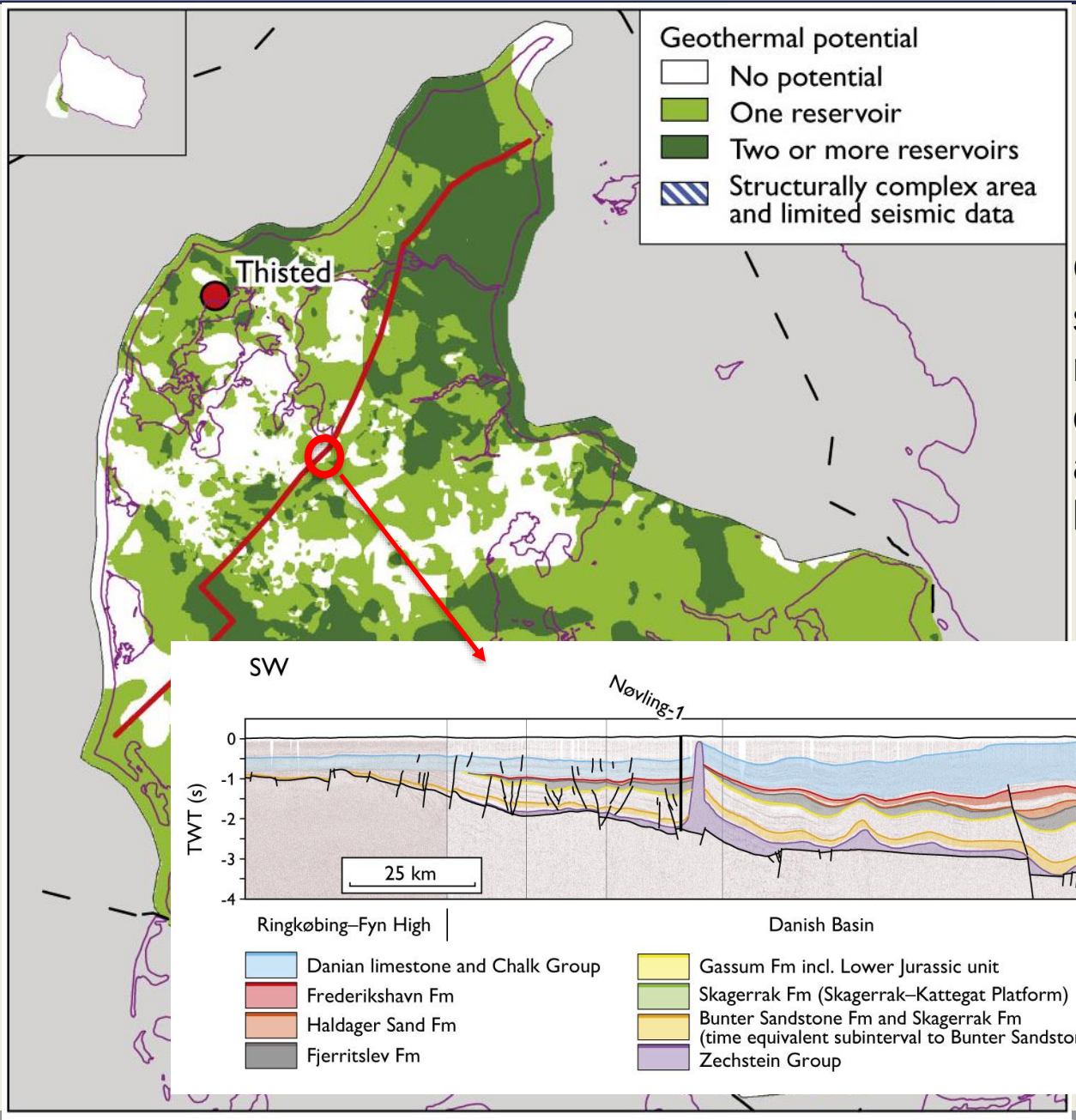
An interactive 3D tool visualises the subsurface topography of mapped seismic horizons





Interactive maps

Geosections illustrate the subsurface geology on a regional scale, e.g. the occurence of faults, salt diapirs and the distribution of the lithostratigraphic units



The use of the WebGIS portal

The WebGIS portal

(Quality assured and interpreted data)

Overview of the geothermal potential
- nationwide

Regional geological theme maps, e.g.:

- Distribution and depths
- Faults, structures
- Various reservoir parameters:
  - Porosity
  - Potentiel reservoir sand
  - Transmissivity
  - Temperature
- Data coverage and quality

Focus on the depth interval 800 – 3000 meter

Input to

Specifik area of interest

Specifik geological evaluation of the geothermal potential

Input to

Collection of additional geological data (~e.g. seismic data)

Input to

Preliminary calculations of Heat effect, economy and profitability

Thank you for your attention

http://dybgeotermi.geus.dk/

The application has been developed for Danish users and full translation to English has not been implemented yet

Geothermal in a Danish geological context

Glacial and postg.

The shallow underground

The deep undergrund